Space Weather Technical Forecast

Issued on Thursday, 28 September 2023 at 01:12 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-flares (R1-R2 Radio blackouts) throughout. A very slight chance of G1 minor geomagnetic storms on Days 1-2 (27-28 Sep).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low. The largest flare was a C4.7 flare at 27/0546UTC originating from a region just beyond the southeast limb. There remains an ongoing chance of M-flares, with a slight chance of an X-flare.

There are currently eight sunspot regions on the visible disc, with five of these located in the western hemisphere. AR3445 in the southwest quadrant is a moderately large bipolar region, and has been the most active region in the past 24 hours. However, only small changes in evolution have been observed in recent imagery, with some intermediate spots fading. AR3435 remains a moderately large region, currently bipolar, but has started to show signs of becoming unipolar with trailing negative spots fading. AR3447 in the southwest has also simplified slightly, with the previous small delta spot in its intermediate portion fading. AR3449 has shown some growth of its lead spot but weakening in the trailer spots. A new region emerging on the southeast limb has recently been numbered AR3450, and was likely responsible for the C4.7 flare mentioned above. Remaining regions are generally simple and unremarkable.

No potential Earth-directed CMEs have been observed in the past 24hrs.

Solar Wind / Geomagnetic Activity: Solar winds as observed at DSCOVR showed an initial decline from elevated to slightly elevated levels, but have since risen back to elevated. At its lowest, solar winds were 416 km/s at 27/1603 UTC, with peak winds of 507 km/s at 27/1945 UTC. This increase may have been the result of some reconnection to CH50/-. Density was mostly average, rising to above average between 27/1100-1630 UTC. The Interplanetary magnetic field (IMF), Bt, was weak between 1-7nT. The north-south component (Bz) was very variable, ranging from +6nT to -5nT. Phi angle was variable at first, but became positive (away from Sun) from around 27/0350 UTC. It had a couple of brief spells negative (towards the sun) but largely remained negative. Resultant geomagnetic activity started at Active (Kp4) levels, then became Quiet to Unsettled (Kp1-3) from 27/0300UTC.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electron flux was at mainly moderate levels, rising to high between 27/1250-1750 UTC, with a peak of 3760 pfu at 27/1620UTC. Associated 24-hour fluence was initially well below the Active (1e8 integrated pfu) threshold, but has seen a steady rising trend. The observation at 28/0001 UTC was 7.41e7 integrated pfu.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be generally Low, but with a chance of M-class flares, and a slight chance of isolated X-class flares, most likely from the larger sunspot regions in the western hemisphere.

Solar Wind / Geomagnetic Activity: A possible glance from weak CME arrivals cannot be ruled out on Days 1-2 (28-29 Sep), however this is deemed very low confidence.
Solar winds are expected to start at slightly elevated levels at first, most likely as a result of a waning influence of the CH50/- high speed stream. Solar winds are expected to gradually drop back to more ambient levels, with perhaps a rise on Day 4 (1 Oct) in any connection to CH54/+.

Geomagnetic activity is expected to be largely Quiet to Unsettled (Kp 2-3), with a slight chance of Active or perhaps G1/Minor Storm (Kp 5) intervals on Days 1-2 (27-28 Sep) due to any possible further glancing CME effects, although this is very low confidence. Quiet to Unsettled (Kp 1-3) activity is expected to continue through much of the period, with perhaps some Active intervals late on Day 4 (1 Oct) due to a possible coronal hole high speed stream.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at Background levels, with a daily slight chance of an enhancement should any larger flares occur.

High energy electron flux (greater than 2MeV) is likely to see high diurnal peaks through much of the period. The associated 24 hour fluence continues to rise, and will likely pass the Active threshold in the coming days.

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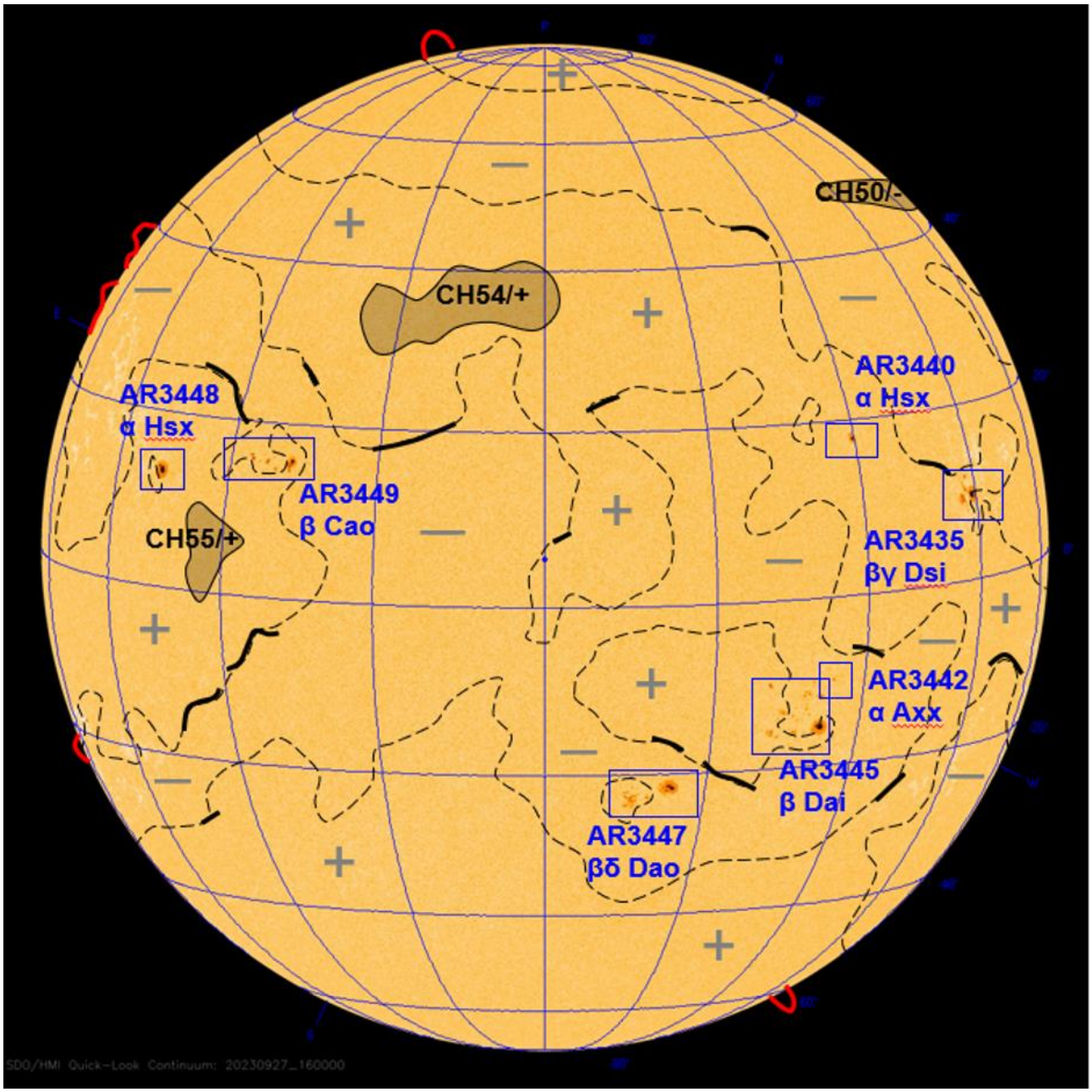
Figure 1. Solar Analysis Valid 27/1630 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are two CMEs in the forecast, both deemed a very low probability of causing a glancing blow at Earth. The first was from a filament eruption from the western limb on 24/1554 UTC, with a possible glancing blow early on Day 1 (28 Sep). The second was from another filament eruption from the northwest quadrant on 25/1540 UTC. Analysis of this CME was tricky with a lack of available imagery due to spacecraft manoeuvres, with a glancing blow late on Day 2 (29 Sep) deemed possible. In all likelihood, these two CMEs will both pass ahead of Earth, hence any impacts are deemed very low confidence.

Solar winds are expected to start at elevated levels at first, most probably as a result of a waning influence of the CH50/- high speed stream. Solar winds are then expected to gradually drop back to more ambient levels, before a connection to CH54/+ becomes possible late on Day 4 (1 Oct).

Geomagnetic activity is expected to be largely be Quiet to Unsettled (Kp 2-3), with a slight chance of Active or G1/Minor Storm (Kp 5) intervals early on Day 1 (28 Sep) and later on Day 2 (29 Sep) due to any possible further glancing CME effects. Quiet to Unsettled (Kp 1-3) activity is expected to through much of the rest of the period. However, a further enhancement is possible late on Day 4 (1 Oct) with any connection to CH54.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	15	15	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
24/2218	Partial	Filament	NW Limb	600 km/s	Early 28 Sep	Missing/glancing
26/0218	Partial	Filament	NW	560 km/s	Late 29 Sep	Missing/glancing

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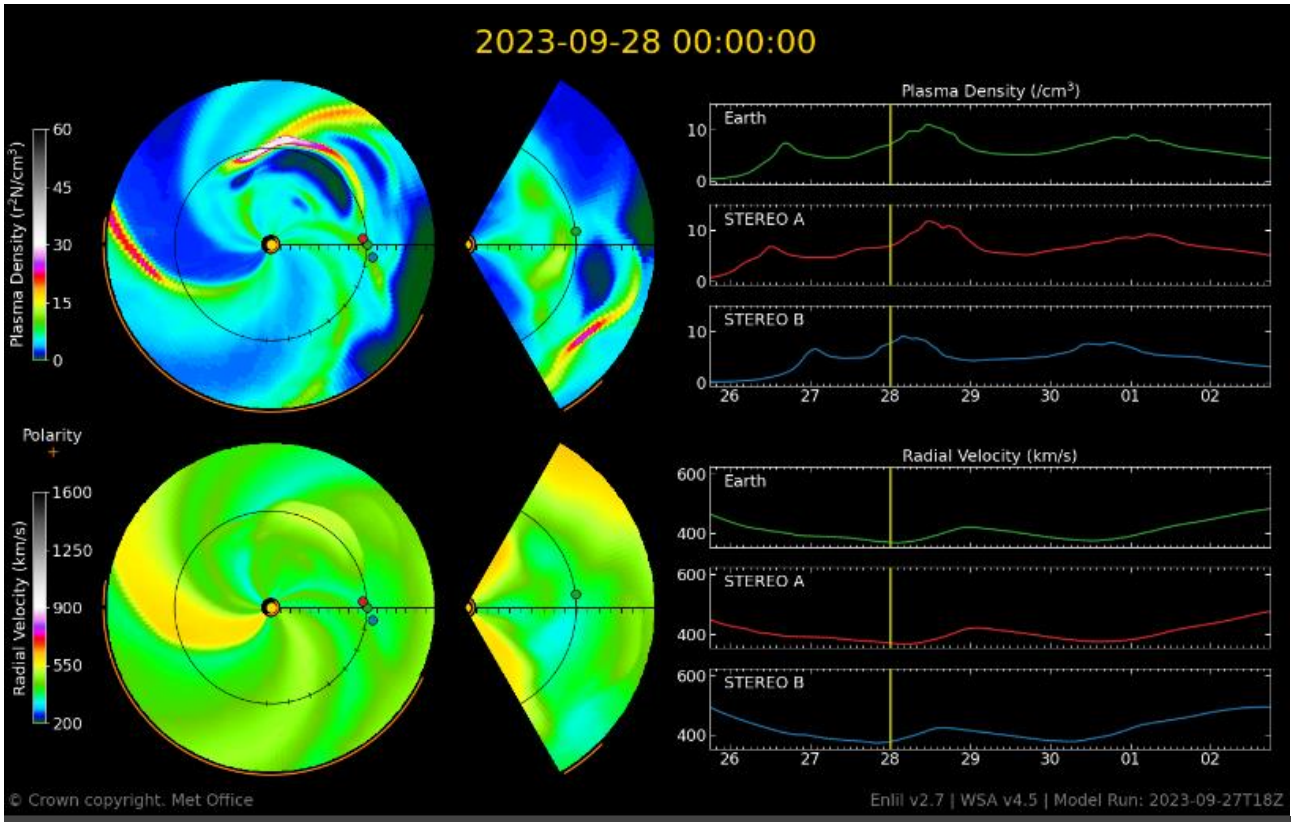
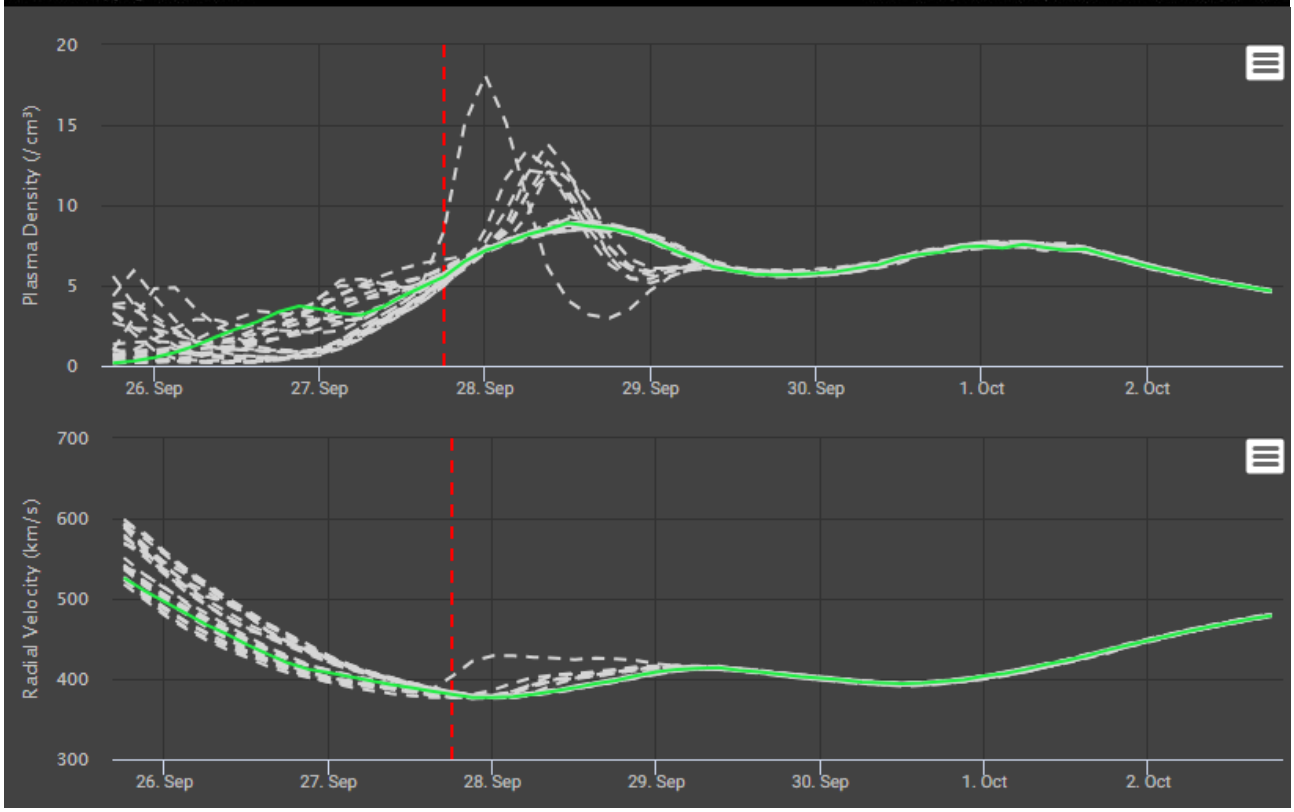
Figure 2: Enlil and ensemble showing possible CME arrivals





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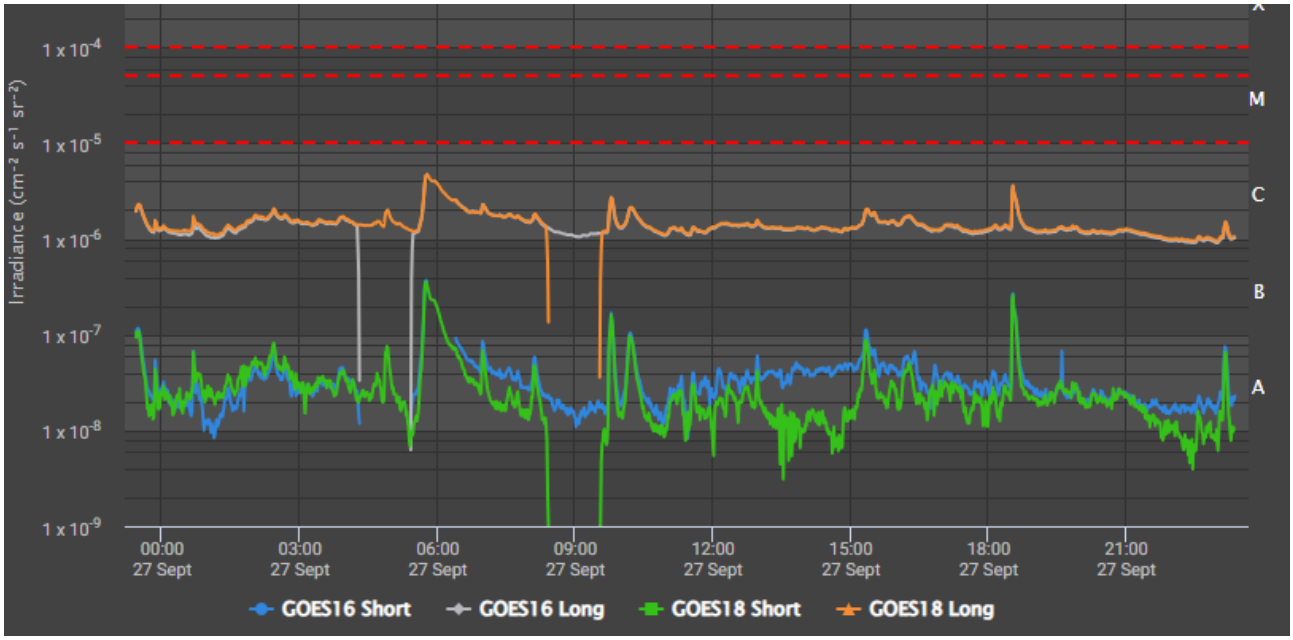
Radio Blackouts - X-Ray Flares:
Solar activity has been Low. The largest flare was a C4.7 flare at 27/0546UTC originating from a region just beyond the southeast limb. There remains an ongoing chance of M-flares, with a slight chance of an X-flare.

There are currently eight sunspot regions on the visible disc, with five of these located in the western hemisphere. AR3445 in the southwest quadrant is a moderately large bipolar region, and has been the most active region in the past 24 hours. AR3435 remains a moderately large region, currently bipolar, but has started to show signs of becoming unipolar with trailing negative spots fading. AR3447 in the southwest has also simplified slightly. AR3449 has shown some growth of its lead spot but weakening in the trailer spots. A new region emerging on the southeast limb has recently been numbered AR3450, and was likely responsible for the C4.7 flare mentioned above. Far-sided seismic data suggests that this could be an active region so will be one to watch as it rotates further onto the disc and becomes more visible. Remaining regions are generally simple and unremarkable.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: GOES 16 and 18 X-ray flux



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Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux observed by GOES16 is likely to persist at background levels, however with five active regions moving across the western disc there is a slight chance that any significant flares could produce an S1 or greater event. The most likely source regions would be AR3435, AR3445 and AR3447.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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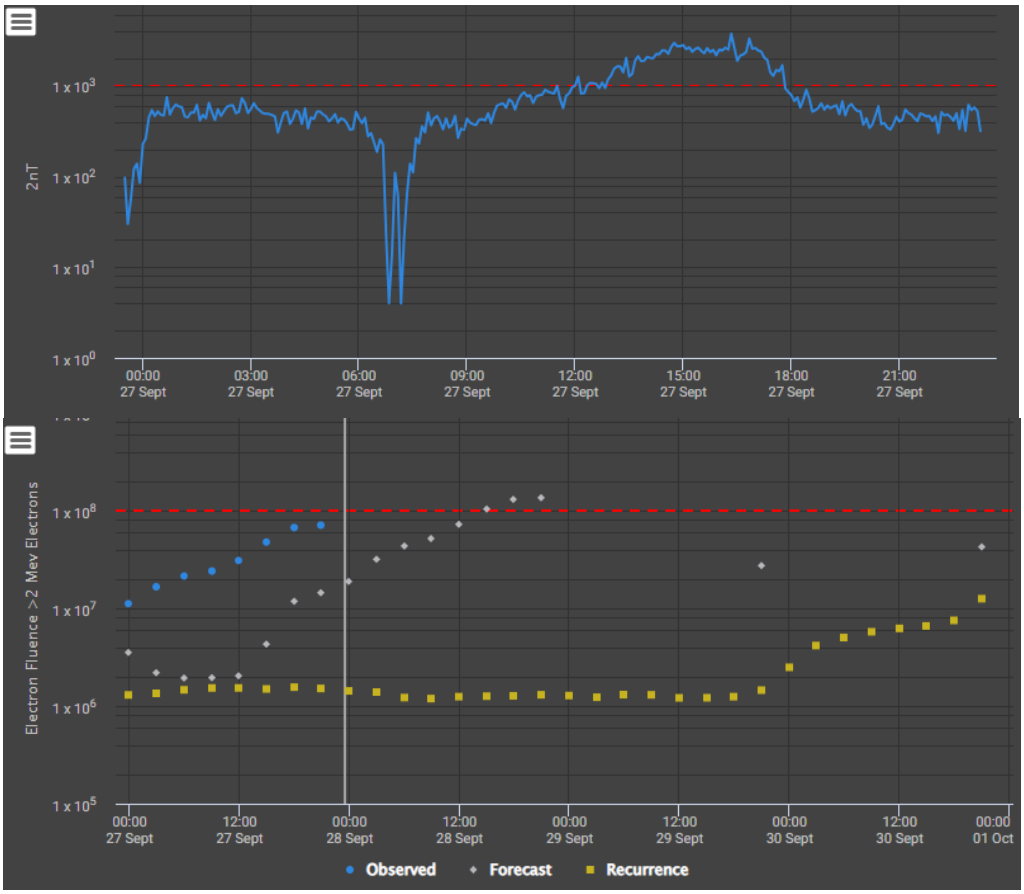
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) observed by GOES16 has seen a rise to moderate levels with a high diurnal peak. Moderate to high diurnal peaks in electron flux are likely in the coming days, however any further CME glancing blows may see the electrons suppressed once again, but this is considered very low confidence.

The associated 24 hour fluence has shown a steady rising trend but currently remains just below the Active threshold. The diurnal high peaks in electron flux will mean its likely that we see the associated 24 hour fluence rise above the Active threshold over the coming days, as is suggested by the REFM model. Confidence into Days 3-4 (30 Sep-1 Oct) becomes lower.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	60	60	40	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: GOES 16 Electron flux and MOSWOC REFM



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